DOCUMENT RESUME

ED 294 571 IR 013 238

AUTHOR Betza, Ruth E.
TITLE Instructional Uses of Computers at the University of Washington.
INSTITUTION Washington Univ., Seattle. Center for Instructional Development and Research.
PUB DATE 1 Aug 86
NOTE 24p.; Paper identified by the Task Force on Establishing a National Clearinghouse of Materials Developed for TA (Teaching Assistants) Training. For a related report, see IR 013 239.
PUB TYPE Reports - Research/Technical (143)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS College Faculty; *Computer Assisted Instruction; *Educational Objectives; Higher Education; *Instructional Effectiveness; Microcomputers; Surveys; *Teacher Attitudes; *Use Studies
IDENTIFIERS Teaching Assistant Training Project; University of Washington

ABSTRACT

This study was conducted to document instructional uses of computers at the University of Washington. A telephone survey of 188 faculty who use computers in their courses was used to obtain information about the ways computers are used in instruction, educational objectives for using the computer, evidence that computer use has benefited students, sources of monetary and resource support for incorporating computers into courses, barriers to computer use, and present and future needs for instructional computing. Responses on computer use and educational objectives were examined within the following framework: (1) the computer as a tool; (2) the computer as tutor; (3) the computer as tutee; (4) computer simulations; and (5) computer literacy. Use of the computer as a tool or for simulations were the most common applications reported. Respondents felt that learning, performance, and preparation for jobs were enhanced by the use of computers. Many faculty felt that they lagged behind peer institutions in educational computing and were concerned about the lack of computers in undergraduate education. The need for more hardware access and capacity, more and better software, more support personnel, and training for faculty was expressed. Two references are listed and survey data are appended. (MES)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

The materials in the Special Collection on the Training of Teaching Assistants were developed through the active efforts of numerous educators who first met at the 1986 National Conference on the Institutional Responsibilities and Responses in the Employment and Education of Teaching Assistants held at the Ohio State University. Assisted by more than 80 individuals, the committee chairs listed below were able to establish the collection which will be developed and maintained by the ERIC Clearinghouse for Higher Education. This arrangement will enable faculty members, faculty developers, administrators, TA supervisors, and graduate teaching assistants to have access to TA training materials produced by institutions across the nation.

Task Force on Establishing a National Clearinghouse of Materials Developed for TA Training

Chair: Jody Nyquist, University of Washington

Subcommittees

ERIC Collection Committee-	Chair: Margaret Pryately University of Oklahoma
Council of Graduate Deans Clearinghouse -	Chair: Sheila Caskey Southeast Missouri State University
Exploration of a Review Process -	Chair: Lynda Morton University of Missouri

ERIC Clearinghouse on Higher Education - Marilyn Shorr

Clearinghouse on ITA Materials - Janet Constantinides

Instructional Uses of Computers at the University of Washington

Ruth E. Betza, Staff Associate
Center for Instructional Development and Research

EXECUTIVE SUMMARY

This study examined instructional uses of computers at the University of Washington. It was intended to describe courses using computers and to provide information about instructional computing.

A telephone survey was conducted with 188 faculty who use computers in their courses, either by requiring students to use computers to achieve course goals or by using computers in the classroom for demonstrations. The 188 faculty gave descriptions of computer use in 481 course sections representing 420 courses taught by themselves and by six on-leave faculty. They provided information about the ways in which computers are being used in instruction, the educational objectives for using computers, the evidence that computers have benefited students, and the sources of monetary and resource support for incorporating computers into their courses. In addition, the faculty told of barriers and of present and future needs for instructional computing.

The majority of respondents require students to use a computer as a tool to help perform a task. The four most frequent uses of instructional computers are as a tool: programming as a means to solve or analyze a problem, statistical analysis, word processing, and electronic communication. Students make extensive use of computers for design, mapping, analysis, and problem-solving. They commonly use graphics, data bases, and spreadsheets. Use of a computer as a tool occurs in many departments, and each use is widespread across campus.

Simulations are also common across campus. Students can use the computer in a simulation, without the simulated processes taking place. Students use or develop simulations to look at processes as diverse as ecology, government, and health care. In addition, students in courses in many departments learn how to program computers. Computer literacy, or the use of a computer to learn about computing in students' fields of study, is rare as the primary focus of a course but is a common secondary purpose for using computers in instruction.

Respondents said that educational objectives such as learning, performance, and preparation for jobs were enhanced by the use of computers. As evidence of efficacy for using computers, many of the respondents said the computer experience was important for students' future employment and had improved student attitude, learning, and performance.

It was found that some respondents were pleased with the available resources but that many faculty felt that they lagged behind peer institutions in instructional computing. Many are concerned at the lack of computers in undergraduate education. Graduate and 400-level courses account for 75% of the courses described in the survey. The main needs expressed by faculty are more hardware access and capacity; a growing preference for microcomputers, classroom computers, and graphics capability; more and better software; more support personnel; and training, release time, departmental recognition, and curriculum assistance for faculty.

The information from the survey has been put into two data bases. One, the Faculty Response Data Base, contains responses to open-ended survey questions on educational objectives, efficacy, source of support, barriers, and present and future needs. The other, the Course Description Data Base, contains abstracts describing how students use computers in each of the 481 course sections and what hardware and software are used. This data base is available for public view and is intended to provide a means of communication for faculty involved with instructional computing.

INSTRUCTIONAL USES OF COMPUTERS AT THE UNIVERSITY OF WASHINGTON

This study was conducted to document instructional uses of computers at the University of Washington. Two goals prompted the study: to describe courses in which computers are being used and to provide information about instructional computing at the University.

In a telephone survey, faculty who use computers in their classes were asked questions relating to instructional computing. The present report summarizes the findings on instructional computing and includes a description of the ways in which computers are being used in instruction, the educational objectives, evidence of efficacy, sources of support, barriers overcome, and current and future needs for instructional computing. In general, the following descriptions of computer use and needs do not identify specific departments. This was intended for two reasons--to guard the confidentiality of individual respondent's remarks and also to underscore campuswide similarities.

Methods and Procedures

The study was a survey of faculty members who use computers in instruction. Names of faculty possibly involved in instructional computing initially came from mailing lists of faculty interested in computing. These lists were obtained from the Office of the Vice Provost for Computing, various Deans' offices, the coordinator of the Olympus Program, and centers for computing across campus. In addition, some department personnel were contacted for names. Finally, interviewed faculty were asked whether the list of names represented their department's instructional computer users.

Respondents were reached by phone. They were told of the study's two goals and asked if they use computers in their teaching. Only faculty who use computers in their teaching were interviewed. Use of computers for teaching was defined to include: required student use of a computer to reach course objectives or faculty use of computers for classroom demonstrations. Faculty use of computers to develop course materials did not fall under the definition of the study.

Since only faculty who use computers in teaching were interviewed, the survey does not represent faculty who **do not** wish to use computers. Nor does the survey represent the University faculty who **do** wish to use computers but who are presently not doing so. Some of the faculty who would like to use computers in their classes were reached by phone but were not formally interviewed. Their informal comments suggested that their reasons for not using computers include lack of hardware, lack of appropriate software, or lack of faculty time to redesign the curriculum for computers. Some departments have no computers for instructional use. Several faculty are currently working on specialized software projects, such as character sets for non-English languages. Considerable effort is being put into such software development, and within another year the diversity of computer use will be increased by the completion of many development projects.

Of the faculty reached by phone, all but one instructional user agreed to be interviewed, indicating a strong interest in the goals of the project. Complete surveys were taken from 188 faculty members, and information on course descriptions was provided for six on-leave faculty by their colleagues. The 188 respondents represent departments across the campus. An estimated additional 80 instructional users could not be reached by phone during the May and June 1986 period of data collection.

Once the respondent agreed to be interviewed, he or she was asked a series of questions. Answers were put into two separate Rbase 5000 data bases to provide data for each of the study's two goals. One cluster of questions elicited course descriptions which were put into a Course Description Data Base. The respondents described 481 course sections, of which 420 are unique courses taught by 194 faculty members. For each course section, the data base describes how students use a computer, how much time students spend using a computer, how important the computer use is to the goals of the course, and what hardware and software are used. From these course descriptions, the ways in which computers are used were categorized to provide a framework for describing instructional computer use for this report. In addition to providing information on instructional uses of computers at the University, the Course Description Data Base provides a means of exchanging information among faculty. For example, an instructor who wants to preview a certain type of software can access the data base to learn whether the software is being used elsewhere on campus and can contact the user. The Course Description Data Base is available through the Center for Instructional Development and Research (CIDR), the Microcomputer Support Group in Parrington Hall, the ACS Computer Information Center at 3737 Brooklyn Avenue N.E., and the ACS Cyber and IBM systems.

The other cluster of questions asked for open-ended responses about objectives, concerns, and needs relating to instructional computing. To uncover their educational objectives, respondents were asked to explain in layperson's terms why they use computers in their courses. They were asked what evidence they had that computers had benefited their students and what types of support they had received to incorporate computers into their courses. Respondents were also asked what barriers they had to overcome in using computers in their courses and what additional support they need to continue or to increase use of instructional computing. Faculty were told that the results of this cluster of questions would be reported only in the aggregate, not associated with the individual faculty member. These responses have been put into a Faculty Response Data Base without faculty names. Responses were coded with keywords for easy retrieval. This information can be accessed through the Office of the Vice Provost for Computing.

The following sections draw upon information from both data bases to summarize the findings on educational uses of computers at the University of Washington. First, a framework for describing the ways in which computers are being used in instruction on campus is introduced, followed by the descriptions of computer use and the educational objectives for using them. Next, the evidence of efficacy is summarized, followed by a brief description of sources of monetary and resource support for instructional computing. Finally, past barriers and current and future needs are discussed.

Framework for Computer Uses: Tool, Tutor, Tutee, Simulation, and Computer Literacy

Educational use of computers is a complicated subject. The 420 described courses illustrate so many examples of computer use that a framework was needed to sort the information. In order to provide a loose structure for classifying the variety of computer

uses, Robert Taylor's (1980) tool, tutor, and tutee framework was adopted and expanded with categories for simulation and computer literacy.

The use of the computer as a **tool** includes applications such as word processing, spreadsheets, and data bases, as well as software for design, analysis, mapping, and communication. A tool helps people perform a task. Learning objectives are derived directly from doing the task, rather than from the tool itself, according to Taylor. The tool, however, facilitates or even makes possible the performance of the task.

The use of the computer as a **tutor** involves learning about a subject unrelated to computers, such as geometry or reading. The computer evaluates student performance, gives feedback, and keeps records on student progress. Educational uses often fall under the rubric of Computer-Assisted Instruction (CAI), in which students are guided through lessons or given practice in a skill. More recently, sophisticated tutorials have been developed to respond to students' individual learning styles. The most advanced tutorials stem from artificial intelligence (AI) and expert systems.

Whereas the user generally needs to know little about a computer to use it as a tutor, the use of the computer as a **tutee** puts the student in the role of controlling or "teaching" the computer. The student, who is now the tutor, tells the computer "tutee" what to do. Tutee use most commonly involves programming and sometimes hardware design.

The **tool, tutor, tutee** framework worked well to describe a broad overview of most instructional uses of computers at the University of Washington. However, another category for **simulation** was added, as simulations were found to be widespread and to span the descriptions and educational objectives of the tool, tutor, and tutee categories. In a computer simulation, the student is taken through a simulation of a real or possible event, without that event actually taking place. Simulations are basically mathematical models, whether equation or logic based, of some process. The user manipulates variables, observes results, and acquires understanding. The purpose is to learn a concept or process.

In addition, a category for **computer literacy** was necessary to refer to knowledge about computers. In this study, computer literacy refers to the objective of familiarizing students with uses of computers in their fields of study.

These categories are not intended to be interpreted rigidly. They are offered as guidelines for describing uses and objectives.

Uses of Computers and Educational Objectives

The uses of computers and educational objectives of courses were found to vary widely, not only among departments but within departments. Each course is unique. However, a particular course might be far more similar to a course in a different department than to others in its own department. For example, statistical courses are offered in many departments for graduate or undergraduate research, using similar software (i.e., Minitab, SPSS) and hardware (VAX, Cyber). No one computer use or educational objective is the domain of a single department. Word processing, data analysis, and design are required in many departments, and patient care is the concern of medicine, nursing, social work, and nutritional sciences. Appendix A contains a frequency listing of educational uses described by the sample.

Tool

Using the computer as a tool is by far the most frequent instructional use of computers at the University of Washington. Students use computers as tools for design, as in architecture, art, and engineering. Students use computers as tools for mapping, as in geography, atmospheric sciences, and landscape architecture. Students use computers as tools for notation of music and weaving. In course projects from computer science to English, from international studies to engineering, students use computers as tools for writing reports and preparing professional looking documents. Documents on disks allow students to write and edit long joint projects, integrating information and correcting factual errors. Computers not only help students to edit writing, they also permit students to edit music or wave forms of speech or defects in images from satellites.

Students also use computers to access and manage data. For projects and research, students access data bases on international treaties, census information, police reports, and satellite data. Students in several departments access Databnk, a large data base developed by a professor in Economics with economic information on different countries. Drama students use data bases to manage lighting control equipment on stage. Education students learn how to use data bases and spreadsheets to manage their classroom records. Students manage bibliographic sources for music research or Library Science. Others use spreadsheets to look at economic issues or to learn math concepts.

Many students and faculty use computers as a communication tool, to communicate with each other via electronic mail. Over electronic mail, students ask questions, and faculty give assignments or feedback. Medical students in Montana and Alaska are taught from the University via modem in a conference group, able to see on a computer monitor what the instructor draws while talking over the phone. And in one writing class, students in the writing lab receive feedback about their writing on-screen from the professor's office.

Tools help students do analyses of all types, from statistical analysis to analysis of social networks in anthropology, from analysis of musical instruments and movements of vocal folds to structural analysis of rocks or of bridges. Computers, via interactive videodisk, help students analyze parts of plays and work through dramatic concepts. Students use computers as tools to analyze language and to acquire and analyze data in laboratories, from psychology to physics.

Respondents who require students to use the computer as a tool said that capabilities of computers ease tasks, enhance learning, and prepare students for jobs. Additionally, respondents said, students should know about computer tools in their fields.

The interviewed faculty often mentioned capabilities of computers, such as speed, flexibility, efficiency, and the ability to work with large volumes of data. "Gathering data used to be terribly time consuming," one respondent noted. "And then data had to be transferred to meaningful numbers. Now computers can be programmed to do all that." Another respondent said, " To understand complex phenomena such as oceans or human behavior, students need massive amounts of information. People can't hold all that information in their heads and work with it."

Faculty from a wide variety of departments did not merely say that computers facilitate calculation--they stated that computers are essential for calculation. A respondent remarked, "The problems could be done with slide rules if the student had ten years instead of ten weeks." Moreover, computers allow students to do far more example calculations.

A typical comment was: "Now students can work with larger data sets and more realistic cases. Hand calculation is not good enough to invert large matrices, and some modern mathematical methods used in differing disciplines were inspired by or created after computers came into being." "Software gives the ability to make fairly accurate calculations of things that would be less precise without it," said another respondent. "Slide rules and calculators fail because of the amount of data and the complexity of algorithms. Columbia Center couldn't be build without such tools." Others noted that "students can do things on computers that they could not produce in reality, such as rotate minerals or draw objects on a screen that cannot be found in nature."

These capabilities result in student learning, according to many respondents. Such tools "shorten the task so that students can spend more time on learning what the method is about and how to interpret it." Another respondent explained, "Computers remove the tedium of repetitive work, and students can spend much more time thinking and asking why." "The computer allows the student to rescue the time spent on strictly manual labor and increases instructional and learning time. The traditional way was with glue and paste," said a professor in a design profession, using the same rationale often cited by respondents who require word processing.

Another major objective in teaching with computer tools is to prepare students for jobs. Many respondents from diverse departments indicated that "no one in the profession does this kind of work without a computer. In the field, it's as important as writing and reading. Awareness of these uses is a requirement."

Tutor

Use of a computer as tutor is rare at the University of Washington, according to the sample. Only a few respondents mentioned using AI or expert systems. CAI is uncommon on campus and occurs only in a few departments. Interactive CAI helps some students to study basic math or writing skills in lower level courses. A few tutorial programs are used as writing aids and as ways to work through elementary music theory or the nursing process on a self-paced basis.

The objective for using the computer as tutor is that it helps students to learn a concept or skill, rather than to perform a task with the software. Only one respondent mentioned the common conception in educational literature that CAI can "augment instruction and free up teachers." Another cited research indicating that "CAI helps high and low learners in academic achievement, reduces learning time, and improves attitude." Another noted that CAI "permits students to review or redo material as they want, to work at their own pace, and to work at their own hours."

Approximately half of the CAI at the University is required to familiarize students with software for the K - 12 grades, in education and English classes intended for teachers. Therefore, the purpose is not for the university students to learn math and language skills with CAI but to learn how to evaluate such software for the purposes of teaching children with it. This is necessary because over half of elementary and about one fourth of high school instructional computer use is CAI (Becker, 1986).

Tutee

The computer as tutee is prevalent in courses relating to mathematics, engineering, business, and the sciences, from fisheries to physics. Students "teach" the computer by programming. FORTRAN is by far the most commonly used programming language, although scores of other languages are used and taught.

Courses involving programming can be divided into two types. In one, students learn how to program for its own sake; but in the other, students program an application in a specific discipline, as with a tool.

Learning how to program for its own sake is, of course, an objective of the Computer Science Department. Other departments also offer courses to teach programming for their field, just as most departments offer discipline specific statistical analysis and research methods courses. Specialized courses involving programming are found in Education and English, for example. Courses aimed at teaching programming represent about 10 % of the courses described by the sample. Where programming is the topic, computers are seen as essential to the objectives of the course. "Working with pieces of paper is not good enough," said one programming instructor. "Using computers is the only way students can understand the concepts," said another.

Using programming as a tool is the most frequent single use of instructional computers at the University of Washington. It is mentioned twice as often as the third most frequently required use, the tool of word processing. In these classes, students use programming as a means. Thus, students are both "teaching" the computer as well as using the computer as a tool for problem-solving, data analysis, or calculation. Students learn by teaching. The educational objective for having students write their own programs (a secondary course objective) in order to solve problems (a primary course objective) is that when students break the problem down into component parts, they are sure to understand. As one respondent said, "To a computer, you can't wave your arms. You must write a program to explain to the computer what you want." In contrast, with sophisticated analytical software, it is possible to find the answer without understanding the problem.

Simulation

Use of computer simulations is widespread on campus. While generally thought of as a subset of the tool category, simulations do not fall easily within the tool, tutor, tutee framework. A specific simulation may resemble any of the tool, tutor, tutee descriptions. At the University of Washington, students work with simulations to learn about their subject, as in tutor use. Students program simulations themselves and develop models, as in tutee. And students use simulations to make forecasts of markets or migrations, as with tools.

Simulations are used from business to science, from the humanities to the health fields. With simulations, University of Washington students see how delaying reproduction affects human population growth and age structure or how price and advertising decisions influence industry. They identify high-risk areas in business using simulations with a real firm's records. They look at the dynamics of natural systems such as Mt. St. Helens, terrestrial life, Columbia River salmon, and circulations of oceans and air. With simulations, students can do what is dangerous or even impossible in real life, such as experiment on patients with different treatments or drugs. As one respondent explained, "With simulations, people can try a variety of ways of handling serious problems without risk to patients." With simulations, students can quickly and safely forecast the movement of gasses in nuclear accidents, view the front and back of an object at once, or watch molecules move.

With simulations, time can be slowed down or speeded up. A student can view the ecology of 4,000 years in four minutes. "Some problems, such as ecology, do not lend themselves to short three hour lab periods," a respondent said. "Simulations allow students to look at broader problems and help them understand several biology processes

that are difficult to understand." According to the respondents, simulations encourage exploration and experimentation.

Because simulations illustrate processes, they can show mental processes of the mind or the workings of government. For example, one simulation, developed for an undergraduate political science course, simulates a legislature. The student assumes the role of an elected official who will not be re-elected unless he or she can pass a package of bills against great opposition. The goal is to negotiate. "Lectures are optimal in presenting or introducing students into knowledge of structures of American government," the instructor pointed out. "But unfortunately the processes of American government are impossible to present in lecture mode. With the simulations, the students take control of the learning experience." One student wrote about the legislative simulation, "I couldn't get away from the micro because I found one more thing I could do to pass one more bill."

In discussing the advantages of simulations, faculty frequently mentioned understanding and enthusiasm. In the past, simplified models have been necessary to teach complex phenomena. But, as one person explained, "Simplified models lose the richness and detail of real problems. Computers simulate more complex and realistic problems for students." Another respondent said, "There is no question that the dynamic aspects of systems is better understood if students can actively manipulate the variables." Encouraging "what-if" kinds of thinking, simulations allow students to learn, to forecast, to hypothesize and then test out their predictions. They allow students to see process, rather than only the end product. "Seeing the end product isn't like seeing the thing happening in time or understanding the dynamics," one instructor said. "Once you see it happening, you understand," another faculty member explained. The word "seeing" is metaphorical, as simulations on campus are generally verbal or numerical. Most departments lack the capabilities to run animated or graphics simulations.

Computer Literacy

Computer use has been incorporated into some courses for the purpose of computer literacy--to familiarize students with computer functions and tools in their specialized fields. Few of the 420 faculty-described courses are aimed specifically at computer literacy. However, a number of respondents have incorporated some computer use with the primary objective of introducing students to the implications of computers used in their fields. One of these instructors said that when students have exposure to computers only in connection with analysis of research data, rather than with the applications of computers in their fields, they have a distorted or limited view of how useful computers can be.

Therefore, when the goal of using computers is computer literacy, students are not necessarily trained with these specialized applications, but they are exposed to the usefulness of computers and have some hands-on experience. Instructors stress concepts rather than how to run a computer. Examples of such uses include awareness of software to help with hearing aid selection, to analyze the nutrient content of a patient's diet history, or to monitor change over the course of patient treatment.

Moreover, as mentioned under the computer as tool section, many faculty expressed computer literacy as a secondary objective in using computers as tools, indicating that "students must know about computers and their value to the profession." This was also a rationale for half of the use of computer as tutor.

Evidence of Efficacy

When asked for evidence as to whether computers had benefited their students, faculty pointed to jobs, student motivation, and learning. Some explained that they had no evidence because they had no basis for comparison. Others said it was too early to tell, as the course was new. Appendix B contains a frequency listing of the categories cited for efficacy.

Jobs, the most common evidence cited, were mentioned by respondents in at least 21 areas. These instructors teach courses relating to art, communications, drama, music, economics, forestry, fisheries, education, engineering, business, and computer science. Jobs were cited not only in the abstract ("Students need the computer experience to get jobs") but also as accomplished fact. "There's no question about job placement," said one. "Students are commonly asked about computer experience." Another agreed, saying, "There is a great impact on employment." Respondents cited letters showing the need for graduates with computer experience. They referred to periodic inquiries from prospective employers asking if students had computer experience. Many pointed to job ads. Several respondents indicated that in professions with depressed employment, there is a pocket relating to computer use in which employment is growing. Some graduates have formed their own computer-based business in art, research, or design. A few faculty voiced concern about the competitiveness of their graduates because of limited availability of instructional computing.

Improved student attitude and high motivation due to computer use were also commonly mentioned by faculty from diverse departments. Students go through experiments two or three times, revise their writing or projects, persist for the best solutions in simulations, redo lessons, or spend more time at the computer than required for a high grade. Faculty see the motivation and effort students put into these courses, they hear testimony from students, both present and past, and they receive feedback about computer use on student ratings of instruction. "One quarter we couldn't use the simulations," said one instructor, "and my student ratings dropped by a full point. Students were very disappointed." Another said, "Over the years, student rating forms always say the computer homework is the best part of the course."

Some students approach computers with a fear that is a carry-over from "math phobia," report the faculty. This is important because often students choose "soft" science or non-science fields to avoid computers or mathematics. Yet, at the graduate and sometimes undergraduate levels, students in most departments must confront research which involves math and computers, as the University of Washington is a research oriented institution. Computer phobia, faculty report, lessens or disappears with computer contact.

Learning from using computers and improvement in performance were also mentioned widely. "Last quarter was the first time my class used computers, but the quality and depth of the experiments students could do were much greater than ever before," said one. Another, who had offered optional use for projects, said that "a third of the students in my class chose to use the computer for a class project and came up with surprisingly good designs." And a Shakespeare class that used software on metaphor and imagery "ended up reading The Tempest like no students I ever had," reported the professor. Several mentioned that the computer brings students together outside of class time to communicate about course work.

Faculty also mentioned that students continue to use computers, follow up on projects from class, or change their direction of study because of a particular class. Students are

more capable and have a competitive edge for graduate school and doing research, others believe. And some students have won awards, published articles, or presented papers arising from projects in computer-related courses.

Sources of Monetary and Resource Support

When asked where the monetary and resource support for computing came from, the faculty had diverse answers. Approximately one third mentioned grant funds from companies, particularly the IBM Olympus project, and government sources. These grants have had wide impact on instructional computing on campus. Some research grant funds have been enlisted for instructional computing.

The University itself was mentioned most frequently. Within the University, sources came from the faculty member's department and from computing services within the University, such as Academic Computing Services and the Humanities and Arts Computing Center. A few respondents said that nothing special had been required to incorporate computer use into their courses beyond what had already been in place.

Others said that no support had been given, despite the existence of equipment. As one said, "I got none, asked for none, expected none." Many faculty said they had implemented their computer-related course or developed instructional software on their own, without support.

Barriers Overcome and Current and Future Needs

Because the resources for and needs of courses vary widely, the satisfaction with the hardware, software, and amount of personnel support differs. Of the sample, 17 % said they had no barriers to overcome in using computers. Less than 5 % said that they did not need any more support for instructional computing. Although some respondents were happy with the type and amount of hardware, software, and personnel resources, the following barriers to and needs for instructional computing were reported. Appendix C presents responses to the question asking what support faculty need to better implement computers in their classes. The respondents were not restricted to a fixed number of categories in answering this open-ended question, and the total number of responses was 388. The overview pie diagram in Appendix C shows the percentage of these responses in each of the support categories. In addition, bar graphs detail the frequencies of the more specific needs within each support category.

Hardware

The availability of hardware often determines whether computers can be used in a course and whether a department can offer computing in courses for undergraduates. Therefore, the lack of hardware is a frequent concern of the interviewed faculty. Most feel that access to or capacity of computers are perhaps the key variables affecting whether students will use computers successfully.

Lack of access to computers means that although computers exist for a particular course, the availability is limited. Lab hours may be restricted (Monday to Friday, 9 to 5). The number of available terminals to a mainframe or the number of microcomputers may be small in ratio to the number of students who need to use them. Twenty terminals may be insufficient to serve several large classes, just as one microcomputer might not suffice for a small course. Thus the problem affects departments with hardware resources ranging from

one terminal "with sticky keys and a 300 baud modem" to labs newly equipped with scores of high powered microcomputers. "It's only been since last year that we had our micros, but already, during the last week of the quarter, students can't get on," a faculty member said, adding, "I haven't been able to log on to the VAX for three days." Another faculty member mentioned being unable to try out a new software program because "there is such a wad of students at the department's handful of machines that it's hard to get to one myself."

Capacity generally refers to mainframes. Although many users may gain access to a mainframe at a particular time, the mainframe's response time may slow down considerably. This impairs the interactive nature of the computer. Instead of immediately knowing whether a job has run successfully, the student might have to wait fifteen minutes, only to find that the program did not run because of a spelling error and must be resubmitted. "What students could do in one hour they need five hours to do," explained a respondent. As another put it, "The faster the VAX runs, the less students have to suffer."

Access and capacity are not simply barriers that have been overcome in the past. They are also present problems. During the Spring 1986 period of data collection, many respondents complained about "serious peak load problems," particularly regarding VAX systems--in business, social sciences, math, engineering, computer science. The burden is augmented by a great deal of down time on certain mainframes. Access problems and response time have been costly in terms of student time and frustration. Results, as one person said, are that "students can't get on, morale is low, frustration is high." Another put it more bluntly: "The VAX has been awful this quarter, under capacity and too many people on it." In one class using computers for the first time, students remained at the microcomputers 24 hours a day during the last five days of the quarter, struggling with access and technical problems to complete a group writing project. They had no sleep and felt highly frustrated, despite turning out the best work ever in history of the class.

Respondents mentioned their personal solutions to the access and capacity problems. Some cut down on assignments because of the problem. Others compensate by not demanding a fast turn around. Others simply limit the number of students in their classes. A few have rented computers for their students to use.

The most frequently proposed solution involves **more** computers. Many faculty want to expand computers into undergraduate classes but cannot because of insufficient computing facilities. Of the 420 courses described by respondents, graduate and 400-level courses, which occur in approximately equal numbers, account for 75% of computer-related course offerings, with 100-level courses making up less than 3%. Course level frequencies are listed in Appendix D. Some of the 100- and 200-level course numbers represent only one section in which computers are used, out of dozens in which no computers are available. The writing courses in the English Department are an example. Several departments have discussed requiring certain undergraduate level courses now using computers but cannot because the existing computer facilities could not handle the extra students.

More computers and more access, however, obscure the diversity of hardware needs that faculty have. For some, the lack is felt most keenly with shortages or lack of peripherals--printers, plotters, special keyboards, input devices, high resolution color monitors. Many are happy with the VAX, but not with the crowding problems. Although the Cyber received few compliments, many who have no access to it voiced a desire to use it. Courses aimed at preparing students for jobs need the particular hardware of the profession. "Because we train students for the field, we need a variety in hardware and software that other departments might consider duplications," one respondent said. Far

more often, respondents expressed a need for microcomputers, sometimes specifying brand, sometimes not.

Instructional computing is shifting rapidly toward **microcomputers**. Many respondents have moved from a mainframe or mini to micros, or plan to do so. Microcomputers are valued because they lend themselves to diversity in specialized software or graphics capability. Respondents would like a variety of microcomputers, depending on the specialized needs of a course. A major obstacle for many respondents is that their own personal computer is a different brand than their department's microcomputers.

In addition to expressing a preference for microcomputers, faculty in most departments voiced a need for computers in classrooms. A **classroom computer** would enable lecturers to demonstrate the latest weather map, to access a national data base, or to show how an equation is plotted. "My students often leave confused because I can't demonstrate processes during lecture that a good simulation would show," one respondent said. Another commented, "The best way to teach my subject is live demonstration, but there is no projection system to a large screen." Others pointed out the need for "easy graphing of high quality, done as you compute."

A computer in a classroom, however, requires more than a "micro on wheels." Some uses require a modem, and this means having a phone outlet in the classroom. Few classrooms are currently equipped in this way. Often faculty need better graphics capabilities and high resolution. And classroom use requires a good projection device, something almost uniformly lacking on campus. One large monitor, faculty said repeatedly, is insufficient for 35 or more students to see at once.

Whether in or out of class, many faculty want **graphics** capabilities, both hard copy as well as on-screen. But the definition of "graphics" changes according to need. For some, graphics means the ability to chart information, as in pie charts or histograms. However, by graphics, many faculty mean the ability to make the computer plot "Y is a function of X" so that students can see a curve representing what is occurring in a problem, rather than just numbers. As one instructor said, "Without the graphics to show the mathematical processes, students end up learning what they did wrong, but not why." Others would like 3-D graphics to display data and make data easier for students to read. Courses involving design or mapping, as in architecture, engineering, and art, also require good graphics capabilities. "The concepts in graphics courses aren't concepts humans readily accept without seeing them," one instructor explained. Many faculty dream about Computer-Aided Design (CAD) systems.

Some faculty are looking ahead to computer driven videodisk for teaching foreign languages or for doing more realistic patient simulations.

Software

References to software barriers and needs relate to more software, better software, or software development. As with hardware, the responses are diverse. For example, respondents said both of the following: "The software on the Cyber and VAX is limited" and "We can't do a lot with our application because that can only be used with the VAX (or Cyber), and we don't have enough access for undergraduates."

In some cases, software already exists that would well serve the needs of a course, but funding for purchase is lacking, or else the software does not run on the available hardware. Some courses use software that could be better. "Some of what we use is

seven or eight years old," said one person, "and I make excuses for the nature of the package." When needed software is not commercially available or appropriate, it must be developed--and that means time, program support, and funding. Some students use demonstration disks to evaluate the software of their profession, as their department does not have the resources for the real software. Site licenses have been proposed to maximize the money for software, when applicable.

The multiplicity of operating systems is "a headache" for many. Software must be modified for different systems. "Because of changes in operating systems, I spend too much time programming and debugging, on my own time," said one person. "Operating systems confuse the 200 level students," said one respondent. But they also confuse the faculty. "The different operating systems scared me away," confided one. Another commented, "To transfer to new systems, we need to learn the new operating systems. Learning new instructional material for each new system takes time."

Other faculty would like a variety of networking capabilities, from local networks for communication with students to large national networks for data base access. Local networking would extend some sophisticated peripherals to more than a few machines. Larger networking systems would enable students to interact with hospitals for real patient data or to communicate with Dow Jones in New York or with banks for real information on finance.

Faculty would like a range of software such as sophisticated signal analysis software, software on climate models, software for dye tests, color mixing, and design programs, and style analysis for writing. Faculty in the sample voiced a great desire for more simulation, either to buy or develop. For example, simulations could do what-ifs with landscape to anticipate objections to development sites. Some faculty want AI and expert systems; however, one of them commented, "I don't even think about it. It is out of the realm of expectation."

Support Personnel

It is not surprising that hardware received the largest share of comments on past barriers and future needs. Without the hardware, there can be no computing. Similarly, it is not surprising that software received many comments. Without the software, the hardware will not assist educational goals. The technology, however, is only part of the instructional computing story. In addition, a wide net of people support is needed--including maintenance and technical support, consulting support to help students as well as to help faculty with curriculum development, and general support personnel. Most important among the people support are the faculty members themselves. It should be noted that these issues of lack of support personnel and resultant demands on faculty time occur commonly across campus, from departments with many computers to those with a few. "We have enough hardware and software, just not enough people," one person said. Many respondents see the need for support personnel as critical.

While some departments have fully staffed labs with technical and consulting support, others do not. Many respondents voiced the concern that their departments lacked **maintenance** and **technical** support personnel to take care of the equipment. Others worried that after certain grant programs such as Olympus terminate, there will no longer be maintenance for their computers. In some departments, when technical problems arise or the system crashes, the system cannot quickly be repaired, and students lose work. One respondent told of a problem arising from lack of funding when a major company donated an expensive microcomputer workstation, and no maintenance support was available.

Finally, another company donated the support. "This incident strained relationships with the donor company," said the respondent.

In some departments, when the hardware goes down or when the software has bugs, faculty members are called upon to act as technicians. This problem occurs in departments with many computers as well as in departments with only a few. Those faculty who have invested the time to learn repair and maintenance of computers have large demands on their time. "If the system goes down, I have to fix it," said one respondent. "This is not a good use of my time." Another said, "I spend an inordinate amount of personal time doing what a technician could do faster without detracting from teaching." Some respondents said that when the computers have problems, they have no recourse but to ask one of their colleagues to help them.

Another major area of concern is for instructional **programming** support. "We need systems programmer support, controlled by our own department," said one respondent, echoing faculty in diverse departments; "We have highly specialized applications and needs for classwork." As mentioned above, software frequently needs to be developed or modified for courses. Much of this work is being done by faculty, and much of it is being done on personal time, without pay. Strikingly, the survey revealed that over half of the respondents have been personally involved in software development for their courses.

Support is also needed for keeping labs open and for **consulting** to help students. Many respondents called for graduate or technical staff to help students. Referring to a department with a single TA position in its lab, one instructor reported that "the TA said she cannot continue living in the lab." Others mentioned the need for full-time permanent consulting personnel--"Somebody who doesn't graduate. We train people and they leave." Some faculty must rely on knowledgeable students to help their classmates.

While some departments have adequate consulting help for students, in other areas it is once again the faculty members who spend time training students how to use the computers. "Consulting support for helping students is substantial. They need to be shown and helped. I cannot do it all myself," said one. Another commented, "I spend all my time training students how to use the machines."

And it is not only the students who need consulting help. Many respondents are painfully aware of their own need for **training**. Whether they are new to computers or have been working with computers for thirty years, faculty voiced the need for release time or educational programs for themselves and their colleagues. Many faculty mentioned that they are completely self taught. "The University should invest more in our training," said one. Another said, "I need time to figure out how to use computers with ease. I can't justify all the time it takes to figure out computers."

This learning involves not only using computers but also learning how to teach with them. Learning how to incorporate computers into the **curriculum** takes time and planning. A frequent comment referred to the need for faculty to become familiar with what is available and how to incorporate it. "If we had more faculty who could learn fast enough to keep up with the demand with skills in applications software, we would serve students' needs better," said one. Many pointed to a need for release time or personnel support for curriculum development and development of course materials. Such materials are "a huge initial investment, but like a book, you get benefits year after year," one respondent pointed out.

It is clear that, despite the use of computers as a time saving device, instructional computing can mean a considerable **time** investment for faculty. While some instructors

walk in easily to existing courses with computers, many have said that preparation for courses involving computers requires much more time than for traditional courses. "Setting up a course of this nature requires far more planning than for a lecture course," said one person, noting that faculty must survey and perhaps develop software, and that they must make sure the software runs on the existing machines. "Some faculty get consumed by implementing computers in their courses," noted another respondent.

A major reason why instructional computing is becoming so widespread at the University of Washington appears to be that scores of individual faculty members are devoting enormous effort to making instructional computing possible for their students.

However, many respondents felt that faculty are not adequately rewarded for their efforts in instructional computing. Some faculty members are reputed by their colleagues to be keeping the system running for other people's classes, developing software used by hundreds of University of Washington students, or donating vast amounts of time to training students. Nonetheless, they have been passed over for salary increases and other benefits, because some departments do not consider such efforts to be scholarly work. Some department heads do not view putting in 900 hours over five years to develop software used by dozens of classes as equivalent to writing a text. Respondents also frequently mentioned resistance to computers by other faculty, even in departments where computers are most prevalent.

Lastly, some faculty do not even have computer access themselves. Some get around this problem by using secretarial computers between noon and one o'clock. Many have purchased their own microcomputers. Some respondents feel that faculty should have access to microcomputers on campus. As one professor put it, "Those who have their own computers at home spend more time at home doing their work and are therefore less accessible to students."

CONCLUSION

The faculty interviewed in this survey are unified by their dedication to instructional computing for their students and by their own sacrifice of personal time for this goal. Their computer uses and needs are a complex issue, and it has only been possible to report on major trends. Although only faculty with access to and use of instructional computers were surveyed, similarity **and** diversity exist within that group relating to available computing resources (hardware, software, support personnel, etc.) and to the educational needs of particular courses.

It was found that some respondents were pleased with the resources available to them or felt that the resources were moving in a reasonable direction. Many said that instructional computing has improved greatly. "We have had an order of magnitude change in the last two years," said one. Faculty from two or three fields felt that they had excellent computer resources for teaching purposes compared to their peers around the country.

It was also found that many faculty feel that they lag behind other institutions for computing in their particular field. Aside from respondents in the few areas well satisfied with their computing resources, most of the faculty from all over campus expressed needs for more instructional computing. For example, faculty told of a lack of instructional computing resources in the hard sciences, in medicine, and in the humanities. In addition, some respondents noted that some departments have been blessed with far more computer resources than their own. As one respondent commented, "The University is not supposed to be leaving behind vast segments of its population."

The main needs expressed by faculty are more hardware access and capacity; a growing preference for microcomputers, classroom computers, graphics capability; more and better software; and more support personnel. Faculty find maintenance a serious obstacle to instructional computing, and this obstacle occurs in departments with many as well as a few computers. Many are concerned at the lack of computers in undergraduate education. As one respondent said, "The UW tries hard to keep up with high standard technical education. To do this, students need an early introduction to the high technology they will meet in daily practice." Faculty from across the campus voiced the need for their own training as well. Release time, departmental recognition, and additional curriculum assistance were frequently cited.

The responses of 188 faculty members have been reported here. Each individual's uses of instructional computing are as varied as each department or course's needs. Although it has been possible to describe instructional computing at the University of Washington, it should be noted that this report offers only a general overview. It obscures the fact that while a specific need may appear widely on campus, a particular department may have a large projection system but no software, whereas another may have all the computing power it needs but no maintenance support. Thus, faculty needs differ enough, from hardware to the definition of graphics, that their voices need to be heard on a case by case basis. Decisions about instructional computing must take the varied and particular cases into consideration.

This study has begun to raise the questions that need to be addressed about instructional computing. One data base is available to help faculty find out more about instructional computing. The information in both data bases will allow for more specific analysis of instructional computing for future decisions.

References

Becker, Henry Jay. Instructional Uses of School Computers: Reports from the 1986 National Survey, Issue No. 1. Baltimore, MD: Center for Social Organization of Schools, The Johns Hopkins University, 1986.

Taylor, Robert P. The Computer in the School: Tutor, Tool, Tutee. New York: Teachers College Press, 1980.

Appendix A

Educational Uses of Computers at the University of Washington

Frequencies of responses for educational uses of computers are listed from the Course Description data base. Responses represent 188 faculty and 481 course sections, of which 420 are unique courses. The information is drawn from the respondents' descriptions of computer use in courses.

Caution must be taken with a too detailed numerical interpretation, as responses are frequently double coded; i.e., "programming/tool" might have a second coding as "analysis" or "calculation." In addition, the tool, tutor, tutee, simulation categories should not be interpreted too rigidly.

Frequency	Codeword	Educational Uses	Category
139	programming/tool	programming as a means	tutee/tool
98	statistical	statistical analysis	tool
72	wp	word processing	tool
58	mail	electronic mail	tool
50	simulation/use	use of simulation	simulation
46	programming/learn	learning programming	tutee
43	spreadsheets	spreadsheets	tool
33	graphics	graphics, CAD	tool
31	analysis	analysis, general heading	tool
30	problem-solving	problem-solving, general heading	tool
28	database	data base	tool
24	CAI	computer-assisted instruction	tutor
22	analysis/numerical	numerical analysis	tool
21	calculation	calculation	tool
19	analysis/structural	structural analysis	tool
19	design	design	tool
18	database/access	access to data base	tool
16	analysis/data	data analysis	tool
12	database/management	data base management	tool
12	model/development	development of a model	tool (tutee)
9	database/bibl	bibliographic data base	tool
9	routines	routines	tool (tutee)
9	simulation/develop	development of a simulation	simulation
9	music	music software	tool
8	model/use	use of a model	tool
8	hw/development	development of hardware	tutee
8	chart	chart software	tool
7	mapping	mapping	tool
7	programming	unspecified as tool or learn	unknown
5	AI	artificial intelligence	tutor
5	image.processing	image processing	tool
3	analysis/cost	cost analysis	tool
3	expert.system	expert system	tutor
3	simulation/game	simulation game	simulation
3	data/access	data access	tool
3	plotting	plotting	tool
3	forecasting	forecasting	tool
3	videodisk	videodisk	tool

Appendix B

Evidence of Efficacy

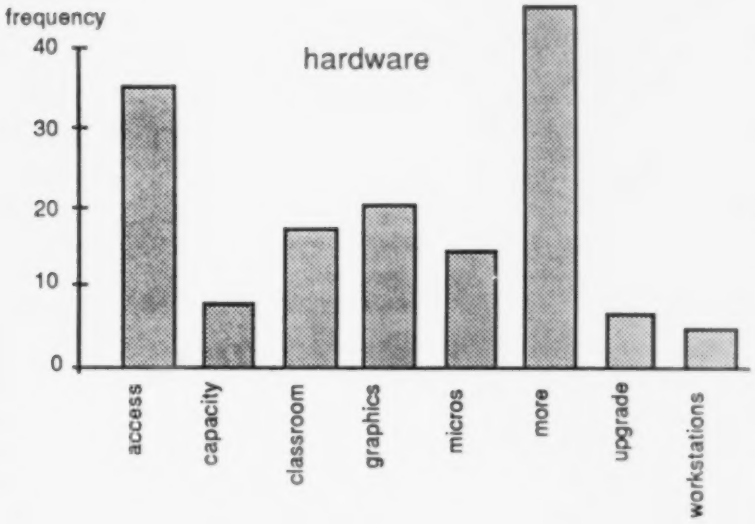
Respondents were asked the question, "What evidence do you have that computer use in your class benefited your students?" The Faculty Response data base contains abstracts associated with the following codewords.

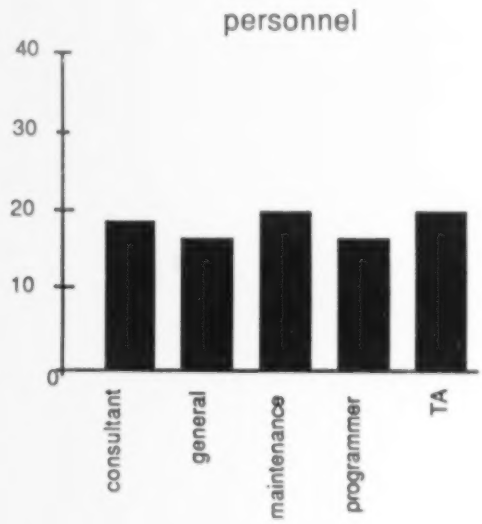
Except for "blank" and "none," the categories are not mutually exclusive.

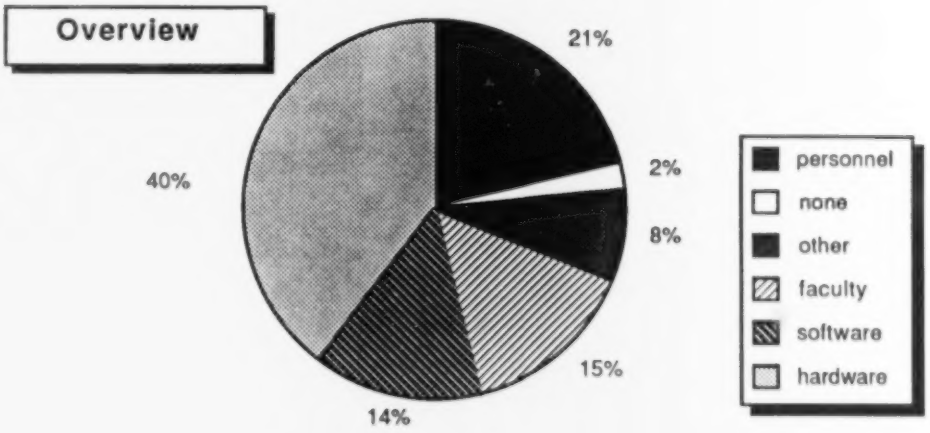
Frequency	Codeword	Explanation
75	jobs	students get jobs or interviews, are more marketable
43	attitude	students liked computers, were enthusiastic, overcame phobia
19	learning	students learn and do better in class
19	use	students use computers after they finish the course
19	blank	no response
17	testimony	students say computer experience was valuable, or that they learned
14	early	too early to tell, the class is too new or in future, respondent is new
13	school	computer coursework prepares students for school or research
13	task	students do better in class or productivity increases
9	sri	student ratings of instruction
8	papers	students published, presented papers, won awards based on computer coursework
8	circular	respondent felt evidence not necessary because the course cannot be taught without computers
7	none	no evidence; no comparison
6	misc	miscellaneous

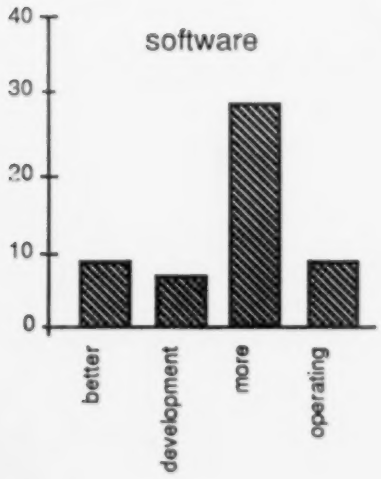
Appendix C

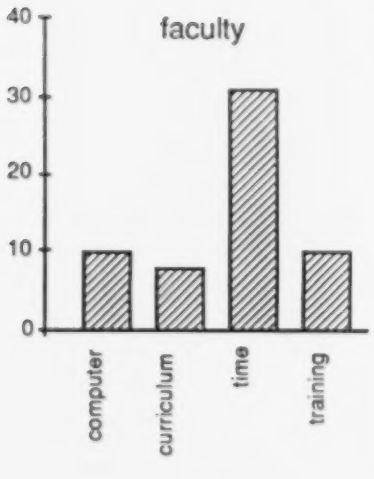
Support Needed to Better Implement Instructional Computing

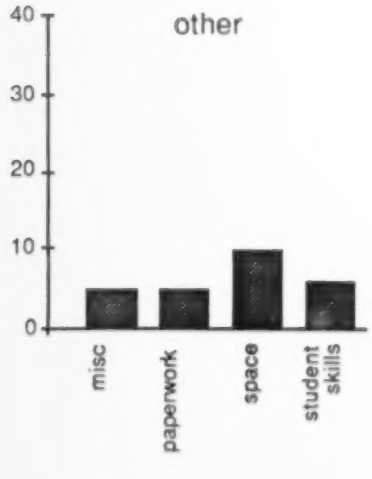












Appendix D

Frequencies of Course Numbers Appearing in the Course Description Data Base

Faculty in the sample gave information on 481 course sections, of which 420 are unique courses. Therefore, the sample described multiple sections of some courses. In contrast, some course numbers represent only one computer section out of a multi-sectioned class. Not all of the University of Washington classes using computers are represented in the sample.

Frequencies of Course Sections

Course Number	Number of Sections	Percent
99	1	.2
100-199	13	2.7
200-299	29	6.0
300-399	78	16.2
400-499	170	35.3
500-599	188	39.1
unknown	2	.4
TOTAL SECTIONS	481	

Frequencies of Unique Course Numbers

Course Number	Number of Courses	Percent
99	1	.2
100-199	11	2.6
200-299	26	6.2
300-399	67	16.0
400-499	143	34.0
500-599	170	40.5
unknown	2	.4
TOTAL COURSES	420	